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- 14 [6,536,037](#) **Identification of redundancies and omissions among components of a web based architecture**
- 15 [6,519,571](#) **Dynamic customer profile management**
- 16 [6,473,794](#) **System for establishing plan to test components of web based framework by displaying pictorial representation and conveying indicia coded components of existing network framework**
- 17 [6,405,364](#) **Building techniques in a development architecture framework**
- 18 [6,370,573](#) **System, method and article of manufacture for managing an environment of a development architecture framework**

- 19 6,324,647 **System, method and article of manufacture for security management in a development architecture framework**
- 20 6,256,773 **System, method and article of manufacture for configuration management in a development architecture framework**
- 21 6,144,953 **Time-constrained inference strategy for real-time expert systems**
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1 [Special issue: AI in engineering](#)

D. Sriram, R. Joobhani

April 1985 **ACM SIGART Bulletin**, Issue 92

Publisher: ACM Press

Full text available: [pdf\(8.79 MB\)](#) Additional Information: [full citation](#), [abstract](#)

The papers in this special issue were compiled from responses to the announcement in the July 1984 issue of the SIGART newsletter and notices posted over the ARPAnet. The interest being shown in this area is reflected in the sixty papers received from over six countries. About half the papers were received over the computer network.



2 [The HiPAC project: combining active databases and timing constraints](#)

M. J. Carey, M. Livny, R. Jauhari

March 1988 **ACM SIGMOD Record**, Volume 17 Issue 1

Publisher: ACM Press

Full text available: [pdf\(1.39 MB\)](#) Additional Information: [full citation](#), [abstract](#), [citations](#), [index terms](#)

The HiPAC (High Performance Active database system) project addresses two critical problems in time-constrained data management: the handling of timing constraints in databases, and the avoidance of wasteful polling through the use of situation-action rules that are an integral part of the database and are monitored by DBMS's condition monitor. A rich knowledge model provides the necessary primitives for definition of timing constraints, situation-action rules, and precipitating events. The ...



3 [The consensus problem in fault-tolerant computing](#)

Michael Barborak, Anton Dahbura, Minošlaw Malek

June 1993 **ACM Computing Surveys (CSUR)**, Volume 25 Issue 2

Publisher: ACM Press

Full text available: [pdf\(4.80 MB\)](#) Additional Information: [full citation](#), [references](#), [citations](#), [index terms](#)



Keywords: Byzantine agreement, consensus problem, decision theory, processor membership, system diagnosis

4 [Software engineering for real-time: a roadmap](#)

Hermann Kopetz

May 2000 **Proceedings of the Conference on The Future of Software Engineering**

Publisher: ACM Press



Full text available:  pdf(1.03 MB)Additional Information: [full citation](#), [references](#), [citations](#), [index terms](#)

Keywords: composable, distributed systems, real-time systems, system architecture, validation

5 Human-Computer Interaction in the Control of Dynamic Systems

 William B. Rouse

March 1981 **ACM Computing Surveys (CSUR)**, Volume 13 Issue 1

Publisher: ACM Press

Full text available:  pdf(2.77 MB)Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

Modes of human-computer interaction in the control of dynamic systems are discussed, and the problem of allocating tasks between human and computer considered. Models of human performance in a variety of tasks associated with the control of dynamic systems are reviewed. These models are evaluated in the context of a design example involving human-computer interaction in aircraft operations. Other examples include power plants, chemical plants, and ships.

Keywords: aircraft, control, dynamic systems, human-computer interaction, mathematical models, system design, task analysis

6 Fault-tolerant task management and load re-distribution on massively parallel

hypercube systems

I. Ahmad, A. Ghafoor

December 1992 **Proceedings of the 1992 ACM/IEEE conference on Supercomputing**

Publisher: IEEE Computer Society Press

Full text available:  pdf(1.16 MB)Additional Information: [full citation](#), [references](#), [index terms](#)

7 Session 5: Two processor scheduling with real release times and deadlines

 Hui Wu, Joxan Jaffar

August 2002 **Proceedings of the fourteenth annual ACM symposium on Parallel algorithms and architectures**

Publisher: ACM Press

Full text available:  pdf(157.43 KB)Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

In a hard real-time system, critical tasks are subject to timing constraints such as release times and deadlines. All timing constraints must be satisfied when tasks are executed.

Nevertheless, given a set of tasks, finding a feasible schedule which satisfies all timing constraints is NP-complete even on one processor. In this paper, we study the following special non-pre-emptive two processor scheduling problem: Given a set of UET (Unit Execution Time) tasks with arbitrary precedence constraints ...

Keywords: feasible schedule, release time and deadline, successor-tree-consistency, task scheduling

8 Minimizing total completion time on uniform machines with deadline constraints

 Teofilo F. Gonzalez, Joseph Y.-T. Leung, Michael Pinedo

January 2006 **ACM Transactions on Algorithms (TALG)**, Volume 2 Issue 1

Publisher: ACM Press

Full text available:  pdf(437.49 KB)Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Consider n independent jobs and m uniform machines in parallel. Each job has a processing requirement and a deadline. All jobs are available for processing at time $t \geq 0$. Job j must complete its processing before or at its deadline and preemptions are allowed. A set of jobs is said to be *feasible* if there exists a schedule that meets all the deadlines. We present a polynomial-time algorithm that given a feasible set of jobs, constructs a schedule that mi ...

Keywords: Mean flow time, deadline constraints, polynomial-time algorithms, uniform machines

9 Scheduling tasks with ready times and deadlines to minimize average error

 W. Shih, J. S. W. Liu, J. Chung, D. W. Gillies
July 1989 **ACM SIGOPS Operating Systems Review**, Volume 23 Issue 3

Publisher: ACM Press

Full text available:  [pdf\(749.44 KB\)](#) Additional Information: [full citation](#), [abstract](#), [index terms](#)

We consider here the problem of scheduling tasks each of which is logically decomposed into a mandatory subtask and an optional subtask. The mandatory subtask must be executed to completion in order to produce an acceptable result. The optional subtask begins after the mandatory subtask is completed and refines the result in order to reduce the error in the result. If the available processor time is insufficient, the optional subtask can be left incomplete. The error in the result of a ...

10 Real time properties: Dual face phased array radar scheduling with multiple constraints

 Qiuhua Cao, John A. Stankovic
September 2005 **Proceedings of the 5th ACM international conference on Embedded software EMSOFT '05**

Publisher: ACM Press

Full text available:  [pdf\(555.14 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Tasks in many real-time applications can be scheduled by variations of rate monotonic or earliest deadline first algorithms. When this is possible, it is satisfying to have formal analysis and performance bounds underlying the use of these algorithms. However, in many applications the simultaneous set of constraints that must be satisfied makes these traditional solutions unsuitable. Practical solutions for these more complicated applications are important. In this paper we develop a novel integ ...

Keywords: dual phased array radars systems, heuristic algorithms, performance, real time systems, resource allocations, scheduling

11 Distributed deadlock detection in Ada run-time environments

 Chia-Shiang Shih, John A. Stankovic
December 1990 **Proceedings of the conference on TRI-ADA '90**

Publisher: ACM Press

Full text available:  [pdf\(1.66 MB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#)

Distributed deadlock detection has been studied in distributed database systems and distributed timesharing operating systems, but has not been widely used in real-time systems such as Ada runtime environments. In this paper we are interested in explicitly tying the formal properties of deadlock algorithms to Ada and its runtime system. We analyze and categorize the deadlock problem in Ada environments into four levels of complexity by using Knapp's hierarchy of deadlock models. To fully su ...

12 On satisfying timing constraints in hard-real-time systems

 Jia Xu, David Lorge Parnas
September 1991 **ACM SIGSOFT Software Engineering Notes**, *Proceedings of the conference on Software for critical systems SIGSOFT '91*, Volume 16 Issue

5

Publisher: ACM PressFull text available:  [pdf\(1.77 MB\)](#)Additional Information: [full citation](#), [references](#), [citations](#), [index terms](#)**13 Scheduling time-constrained instructions on pipelined processors**  Allen Leung, Krishna V. Palem, Amir Pnueli**January 2001 ACM Transactions on Programming Languages and Systems (TOPLAS),**

Volume 23 Issue 1

Publisher: ACM PressFull text available:  [pdf\(357.07 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

In this work we investigate the problem of scheduling instructions on idealized microprocessors with multiple pipelines, in the presence of precedence constraints, release-times, deadlines, and latency constraints. A latency of l_{ij} specifies that there must be at least l_{ij} time-steps between the completion time of instruction i and the start time of instruction j . A latency of

14 A methodology and algorithms for the design of hard real-time multitasking ASICs  Miodrag Potkonjak, Wayne Wolf**October 1999 ACM Transactions on Design Automation of Electronic Systems (TODAES),** Volume 4 Issue 4**Publisher:** ACM PressFull text available:  [pdf\(198.48 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#), [review](#)

Traditional high-level synthesis concentrates on the implementation of a single task (e.g. filter, linear controller, A/D converter). However, many applications—multifunctional embedded controllers intelligent wireless end-points, and DSP and multimedia servers—are defined as sets of several computational tasks. This paper describes new techniques for the synthesis of ASIC implementations that realize multiple computational processes under hard real-time constraints. Our synthe ...

15 Embedded systems: applications, solutions and techniques (EMBS): Profit-driven uniprocessor scheduling with energy and timing constraints  Jian-Jia Chen, Tei-Wei Kuo, Chia-Lin Yang**March 2004 Proceedings of the 2004 ACM symposium on Applied computing****Publisher:** ACM PressFull text available:  [pdf\(235.87 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#)

Energy-aware scheduling has received much attention in recent years, especially for systems with serious considerations on energy consumption. While most previous work focuses on the minimization of energy consumption, this paper exploits the maximization of the entire system profit under energy and timing constraints. We propose a greedy approximation algorithm with a 2-approximation ratio. A fully polynomial time approximation scheme (FPTAS) is also proposed, which is an optimal approximation ...

Keywords: embedded systems, energy-aware scheduling, power management, real-time process scheduling

16 Maximizing rewards for real-time applications with energy constraints  Cosmin Rusu, Rami Melhem, Daniel Mossé**November 2003 ACM Transactions on Embedded Computing Systems (TECS),** Volume 2 Issue 4**Publisher:** ACM PressFull text available:  [pdf\(278.42 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

New technologies have brought about a proliferation of embedded systems, which vary from control systems to sensor networks to personal digital assistants. Many of the portable embedded devices run several applications, which typically have three constraints

that need to be addressed: *energy*, *deadline*, and *reward*. However, many of these portable devices do not have powerful enough CPUs and batteries to run all applications within their deadlines. An optimal scheme would allo ...

Keywords: Power management, operating systems, real-time, reward-based, scheduling

17 Technical Report Column

 Mark A. Weiss

March 1996 **ACM SIGACT News**, Volume 27 Issue 1

Publisher: ACM Press

Full text available:  [pdf\(498.86 KB\)](#) Additional Information: [full citation](#)



18 CPU reservations and time constraints: efficient, predictable scheduling of independent activities

 Michael B. Jones, Daniela Roşu, Marcel-Cătălin Roşu

October 1997 **ACM SIGOPS Operating Systems Review, Proceedings of the sixteenth ACM symposium on Operating systems principles SOSP '97**, Volume 31 Issue 5

Publisher: ACM Press

Full text available:  [pdf\(2.25 MB\)](#) Additional Information: [full citation](#), [references](#), [citations](#), [index terms](#)



19 System partitioning and timing analysis: Hardware-software cosynthesis of multi-mode multi-task embedded systems with real-time constraints

 Hyunok Oh, Soonhoi Ha

May 2002 **Proceedings of the tenth international symposium on Hardware/software codesign**

Publisher: ACM Press

Full text available:  [pdf\(452.60 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)



An embedded system is called multi-mode when it supports multiple applications by dynamically reconfiguring the system functionality. This paper proposes a hardware-software cosynthesis technique for multi-mode multi-task embedded systems with real-time constraints. The cosynthesis problem involves three subproblems: selection of appropriate processing elements, mapping and scheduling of function modules to the selected processing elements, and schedule analysis. The proposed cosynthesis framework ...

Keywords: hardware-software cosynthesis, multi-mode, multi-task

20 Quasi-Static Voltage Scaling for Energy Minimization with Time Constraints

Alexandru Andrei, Marcus T. Schmitz, Petru Eles, Zebo Peng, Bashir M. Al Hashimi

March 2005 **Proceedings of the conference on Design, Automation and Test in Europe - Volume 1**

Publisher: IEEE Computer Society

Full text available:  [pdf\(213.43 KB\)](#) Additional Information: [full citation](#), [abstract](#)



Supply voltage scaling and adaptive body-biasing are important techniques that help to reduce the energy dissipation of embedded systems. This is achieved by dynamically adjusting the voltage and performance settings according to the application needs. In order to take full advantage of slack that arises from variations in the execution time, it is important to recalculate the voltage (performance) settings during run-time, i.e., online. However, voltage scaling (VS) is computationally expensive ...

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21 [Scheduling: Model-based run-time monitoring of end-to-end deadlines](#)

Jaswinder Ahluwalia, Ingolf H. Krüger, Walter Phillips, Michael Meisinger

 September 2005 **Proceedings of the 5th ACM international conference on Embedded software EMSOFT '05**
Publisher: ACM Press

Full text available: [pdf\(272.87 KB\)](#) **Additional Information:** [full citation](#), [abstract](#), [references](#), [index terms](#)

The correct interplay among components in a distributed, reactive system is a crucial development task, particularly for embedded systems such as those in the automotive domain. Model-based development is a promising means for capturing key structural and behavioral requirements *before* implementing code. Current development approaches focus on components as the central development entity, leaving component integration as a separate and error-prone task in later stages of the system develo ...

Keywords: RT CORBA, code generation, components, quality of service, runtime monitoring, service engineering, services

22 [Shortest-path algorithms for real-time scheduling of FIFO tasks with minimal energy use](#)

use

Bruno Gaujal, Nicolas Navet, Cormac Walsh

 November 2005 **ACM Transactions on Embedded Computing Systems (TECS)**, Volume 4 Issue 4

Publisher: ACM Press

Full text available: [pdf\(381.65 KB\)](#) **Additional Information:** [full citation](#), [abstract](#), [references](#), [index terms](#)

We present an algorithm for scheduling a set of nonrecurrent tasks (or jobs) with FIFO real-time constraints so as to minimize the total energy consumed when the tasks are performed on a dynamically variable voltage processor. Our algorithm runs in linear time and thus, in this case, is an improvement over the classical algorithm of Yao et al. It was inspired by considering the problem as a shortest-path problem. We also propose an algorithm to deal with the case where the processor has only a l ...

Keywords: Real-time systems, low-power design, scheduling, voltage scaling

23 [Preemptive Scheduling with Release Times, Deadlines, and Due Times](#)

Charles Martel

 July 1982 **Journal of the ACM (JACM)**, Volume 29 Issue 3

Publisher: ACM Press

Full text available: [pdf\(898.00\)](#) **Additional Information:**

[KB](#)[full citation, references, citings, index terms](#)

24 Advances in embedded software scheduling techniques: Synthesis of real-time embedded software with local and global deadlines

 Pao-Ann Hsiung, Cheng-Yi Lin
October 2003 **Proceedings of the 1st IEEE/ACM/IFIP international conference on Hardware/software codesign and system synthesis**

Publisher: ACM PressFull text available:  [pdf\(91.32 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Current methods cannot synthesize real-time embedded software applications when the global deadline of a task is shorter than the total of all local deadlines along a critical path in the task. This creates unnecessary modeling limitations which directly affect the types of systems synthesizable. We propose a *quasi-dynamic scheduling* algorithm for simultaneously guaranteeing both local and global deadlines, while satisfying all precedence constraints among subtasks and among tasks. Throug ...

Keywords: code generation, quasi-dynamic scheduling, real-time embedded software, real-time petri nets, software synthesis

25 Scheduling of real-time messages in optical broadcast-and-select networks

Maurizio A. Bonuccelli, M. Claudia Clò
October 2001 **IEEE/ACM Transactions on Networking (TON)**, Volume 9 Issue 5

Publisher: IEEE PressFull text available:  [pdf\(298.90 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

In this paper, we consider broadcast-and-select networks based on optical passive stars. In these single-hop networks, communicating pairs can exchange messages directly, without the need to store information at intermediate nodes for later forwarding. Messages are transmitted in a packetized way, and each message has an associated deadline. In order to guarantee the message reception timeliness, we ask that all the messages are received within their corresponding deadline. We show that this sch ...

Keywords: Approximating algorithms, complexity, feasibility test, multimedia, optical broadcast-and-select networks, performance guarantees, real-time transmission, scheduling, single-hop multichannel systems, time-wavelength division multiplexing

26 Compile-time dynamic voltage scaling settings: opportunities and limits

 Fen Xie, Margaret Martonosi, Sharad Malik
May 2003 **ACM SIGPLAN Notices , Proceedings of the ACM SIGPLAN 2003 conference on Programming language design and implementation PLDI '03**, Volume 38 Issue 5

Publisher: ACM PressFull text available:  [pdf\(291.26 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

With power-related concerns becoming dominant aspects of hardware and software design, significant research effort has been devoted towards system power minimization. Among run-time power-management techniques, dynamic voltage scaling (DVS) has emerged as an important approach, with the ability to provide significant power savings. DVS exploits the ability to control the power consumption by varying a processor's supply voltage (V) and clock frequency (f). DVS controls energy by scheduling diffe ...

Keywords: analytical model, compiler, dynamic voltage scaling, low power, mixed-integer linear programming

27 Strategic directions in artificial intelligence Jon Doyle, Thomas DeanDecember 1996 **ACM Computing Surveys (CSUR)**, Volume 28 Issue 4**Publisher:** ACM PressFull text available:  [pdf\(243.02 KB\)](#) Additional Information: [full citation](#), [references](#), [index terms](#)**28 Miscellaneous: Value-maximizing deadline scheduling and its application to animation rendering** Eric Anderson, Dirk Beyer, Kamalika Chaudhuri, Terence Kelly, Norman Salazar, Cipriano Santos, Ram Swaminathan, Robert Tarjan, Janet Wiener, Yunhong ZhouJuly 2005 **Proceedings of the 17th annual ACM symposium on Parallelism in algorithms and architectures SPAA'05****Publisher:** ACM PressFull text available:  [pdf\(234.03 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

We describe a new class of utility-maximization scheduling problem with precedence constraints, the *disconnected staged scheduling problem* (DSSP). DSSP is a nonpreemptive multiprocessor deadline scheduling problem that arises in several commercially-important applications, including animation rendering, protein analysis, and seismic signal processing. DSSP differs from most previously-studied deadline scheduling problems because the graph of precedence constraints among tasks within jobs ...

Keywords: animation rendering, deadline scheduling, multiprocessor job scheduling, simulation

**29 Resource constrained scheduling: Multiprocessor synthesis for periodic hard real-time tasks under a given energy constraint** Heng-Ruey Hsu, Jian-Jia Chen, Tei-Wei KuoMarch 2006 **Proceedings of the conference on Design, automation and test in Europe: Proceedings DATE '06****Publisher:** European Design and Automation AssociationFull text available:  [pdf\(239.22 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#)

The energy-aware design for electronic systems has been an important issue in hardware and/or software implementations, especially for embedded systems. This paper targets a synthesis problem for heterogeneous multiprocessor systems to schedule a set of periodic real-time tasks under a given energy consumption constraint. Each task is required to execute on a processor without migration, where tasks might have different execution times on different processor types. Our objective is to minimize t ...

Keywords: energy-aware systems, multiprocessor synthesis, real-time systems, task partitioning, task scheduling

**30 Energy-conserving feedback EDF scheduling for embedded systems with real-time constraints** Ajay Dudani, Frank Mueller, Yifan ZhuJune 2002 **ACM SIGPLAN Notices , Proceedings of the joint conference on Languages, compilers and tools for embedded systems: software and compilers for embedded systems LCTES/SCOPES '02**, Volume 37 Issue 7**Publisher:** ACM PressFull text available:  [pdf\(224.68 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

Embedded systems have limited energy resources. Hence, they should conserve these resources to extend their period of operation. Recently, dynamic frequency scaling (DFS) and dynamic voltage scaling (DVS) have been added to a various embedded processors as a means to increase battery life. A number of scheduling techniques have been developed

to exploit DFS and DVS for real-time systems to reduce energy consumption. These techniques exploit idle and slack time of a schedule. Idle time can be con ...

Keywords: dynamic voltage scaling, real-time systems, scheduling

31 A tool for the deterministic scheduling of real-time programs implemented as periodic 

 **Ada tasks**

E. W. Giering, T. P. Baker

September 1994 **ACM SIGAda Ada Letters , Proceedings of the second international symposium on Environments and tools for Ada SETA2**, Volume XIV Issue SI

Publisher: ACM Press

Full text available:  pdf(1.57 MB) Additional Information: [full citation](#), [abstract](#), [index terms](#)

In this paper, we describe an experimental tool for the scheduling and execution of real-time programs on a single processor. This tool accepts a real-time program implemented as a system of periodic tasks written in a subset of Ada. It translates the program into equivalent Ada source code in which the task bodies are executed by a run-time dispatcher according to a deterministic, cyclic schedule. The schedule is represented as a table of scheduling actions describing the execution of the program ...

32 Deadline-monotonic software scheduling for the co-synthesis of parallel hard real- 

time systems

P. Altenbernd

March 1995 **Proceedings of the 1995 European conference on Design and Test**

Publisher: IEEE Computer Society

Full text available:  pdf(688.81 KB)

Additional Information: [full citation](#), [abstract](#), [citations](#)

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This paper focuses on software scheduling in hard real-time embedded systems. It uses the deadline-monotonic scheduling heuristics, where the analysis whether the hard real-time conditions are met, is done by a schedulability test. The test presented in this paper overcomes the problems of existing approaches with parallel communicating tasks. The essential of the test is, that the communication caused precedence constraints are mapped to minimum-maximum offset intervals, to deal with multiperiod ...

Keywords: co-synthesis, communication caused precedence constraints, computer aided software engineering, deadline-monotonic software scheduling, embedded systems, fixed offset values, minimum-maximum offset intervals, multiperiod systems, parallel communicating tasks, parallel hard real-time systems, parallel programming, processor scheduling, real-time systems, schedulability test, scheduling

33 On being optimistic about real-time constraints 

 **Jayant R. Haritsa, Michael J. Carey, Miron Livny**

April 1990 **Proceedings of the ninth ACM SIGACT-SIGMOD-SIGART symposium on Principles of database systems**

Publisher: ACM Press

Full text available:  pdf(1.48 MB)

Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

Performance studies of concurrency control algorithms for conventional database systems have shown that, under most operating circumstances, locking protocols outperform optimistic techniques. Real-time database systems have special characteristics - timing constraints are associated with transactions, performance criteria are based on satisfaction of these timing constraints, and scheduling algorithms are priority driven. In light of these special characteristics, results regarding the per ...

34 Issues in partitioning & design space exploration for codesign: Partial task assignment of task graphs under heterogeneous resource constraints 

◆ Radoslaw Szymanek, Krzysztof Krzysztof
 June 2003 **Proceedings of the 40th conference on Design automation**

Publisher: ACM Press

Full text available: [pdf\(343.44 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

This paper presents a novel *partial assignment technique* (PAT) that decides which tasks should be assigned to the same resource without explicitly defining assignment of these tasks to a particular resource. Our method simplifies the assignment and scheduling steps while imposing a small or no penalty on the final solution quality. This technique is specially suited for problems which have different resources constraints. Our method does not cluster tasks into a new task, as typical clust ...

Keywords: constraint logic programming, scheduling, task assignment

35 **DA STANDARDS ACTIVITIES:** Summary: Standard Package Position Papers VHDL

◆ **Model Standards Group**

Lisa Asher

December 1988 **ACM SIGDA Newsletter**, Volume 18 Issue 3-4

Publisher: ACM Press

Full text available: [pdf\(2.29 MB\)](#) Additional Information: [full citation](#), [abstract](#)

The following are abridged versions of position papers being used by the IEEE/DASS in developing the IEEE VHDL standard. These were supplied by Jim Armstrong who is Chairman of the VHDL Model Subgroup. Complete versions of the papers and minutes of the IEEE VHDL Subgroup are archived at the IEEE Computer Society. For further information call Rick Cain at 202-371-0101. I believe that sometime in the fall of 89 *Design and Test* will publish a special issue on the VHDL standard based on the f ...

36 **Virtual simple architecture (VISA): exceeding the complexity limit in safe real-time systems**

◆ Aravindh Anantaraman, Kiran Seth, Kaustubh Patil, Eric Rotenberg, Frank Mueller

May 2003 **ACM SIGARCH Computer Architecture News , Proceedings of the 30th annual international symposium on Computer architecture ISCA '03**, Volume 31 Issue 2

Publisher: ACM Press

Full text available: [pdf\(147.00 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#)

Meeting deadlines is a key requirement in safe realtime systems. Worst-case execution times (WCET) of tasks are needed for safe planning. Contemporary worst-case timing analysis tools can safely and tightly bound execution time on in-order single-issue pipelines with caches and static branch prediction. However, this simple pipeline appears to be a complexity limit, due to the need for analyzability. This excludes a whole class of high-performance processors from many embedded systems. We reconci ...

37 **Combining software synthesis and hardware/software interface generation to meet hard real-time constraints**

◆ Steven Vercauteren, Jan Van Der Steen, Diederik Berkest

January 1999 **Proceedings of the conference on Design, automation and test in Europe**

Publisher: ACM Press

Full text available: [pdf\(127.72 KB\)](#) Additional Information: [full citation](#), [index terms](#)

38 **CASPER: concurrent hardware-software co-synthesis of hard real-time aperiodic and periodic specifications of embedded system architectures**

B. P. Dave, N. K. Jha

February 1998 **Proceedings of the conference on Design, automation and test in Europe**

Publisher: IEEE Computer Society

Full text available: [pdf\(69.57 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index](#)

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Hardware-software co-synthesis of an embedded system requires mapping of its specifications into hardware and software modules such that its real-time and other constraints are met. Embedded system specifications are generally represented by acyclic task graphs. Many embedded system applications are characterized by aperiodic as well as periodic task graphs. Aperiodic task graphs can arrive for execution at any time and their resource requirements vary depending on how their constituent tasks an ...

Keywords: aperiodic task graphs, allocation, distributed systems, embedded systems, hardware-software co-synthesis, scheduling, system synthesis.

39 Session 1B: bidding and bargaining agents I: Multi-issue negotiation under time constraints



 Shaheen S. Fatima, Michael Wooldridge, Nicholas R. Jennings

July 2002 **Proceedings of the first international joint conference on Autonomous agents and multiagent systems: part 1**

Publisher: ACM Press

Full text available: [pdf\(148.83 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index](#)
[terms](#)

This paper presents a new model for multi-issue negotiation under time constraints in an incomplete information setting. In this model the order in which issues are bargained over and agreements are reached is determined endogenously as part of the bargaining equilibrium. We show that the sequential implementation of the equilibrium agreement gives a better outcome than a simultaneous implementation when agents have like, as well as conflicting, time preferences. We also show that the equilibriu ...

Keywords: agendas, game theory, negotiation

40 Providing absolute differentiated services for real-time applications in static-priority scheduling networks



Shengquan Wang, Dong Xuan, Riccardo Bettati, Wei Zhao

April 2004 **IEEE/ACM Transactions on Networking (TON)**, Volume 12 Issue 2

Publisher: IEEE Press

Full text available: [pdf\(519.25 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index](#) [terms](#)

In this paper, we propose and analyze a methodology for providing absolute differentiated services for real-time applications. We develop a method that can be used to derive delay bounds without specific information on flow population. With this new method, we are able to successfully employ a utilization-based admission control approach for flow admission. This approach does not require explicit delay computation at admission time and, hence, is scalable to large systems. We assume the underlyi ...

Keywords: admission control, delay bound, differentiated services, priority assignment, real time, static-priority scheduling, utilization-based

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41 Using self-diagnosis to adapt organizational structures

Bryan Horling, Brett Benyo, Victor Lesser

May 2001 **Proceedings of the fifth international conference on Autonomous agents**

Publisher: ACM Press

Full text available: [pdf\(109.37 KB\)](#)

Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

The specific organization used by a multi-agent system is crucial for its effectiveness and efficiency. In dynamic environments, or when the objectives of the system shift, the organization must therefore be able to change as well. In this paper we propose using a general diagnosis engine to drive this process of adaptation, using the \tems\ modeling language as the primary representation of organizational information. Results from experiments employing such a system in the Producer-Cons ...

Keywords: organization and social structure, organization self-design

42 The Spring kernel: a new paradigm for real-time operating systems

J. A. Stankovic, K. Ramamritham

July 1989 **ACM SIGOPS Operating Systems Review**, Volume 23 Issue 3

Publisher: ACM Press

Full text available: [pdf\(1.17 MB\)](#)

Additional Information: [full citation](#), [abstract](#), [citations](#), [index terms](#)

Next generation real-time systems will require greater flexibility and predictability than is commonly found in today's systems. These future systems include the space station, integrated vision/robotics/AI systems, collections of humans/robots coordinating to achieve common objectives (usually in hazardous environments such as undersea exploration or chemical plants), and various command and control applications. The Spring kernel is a research oriented kernel designed to form the basis of a fl ...

43 A logic base tool set for real-time Ada software development

Michael Moore

June 1991 **Proceedings of the eighth annual Washington Ada symposium & summer SIGAda meeting on Ada: software: foundation for competitiveness**

Publisher: ACM Press

Full text available: [pdf\(1.50 MB\)](#)

Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

This is a report on work conducted privately that explores the use of predicate logic to reason about real-time design. Safety and reliability issues associated with embedded real-time systems make greater demands on development engineers than non-real-time systems whose functional complexity is of similar degree. The effort undertaken here

attempts to provide methods and tools for dealing with both the functional and temporal aspects of software engineering. The goal is to improve the effe ...

44 Scheduling time-critical instructions on RISC machines

Krishna V. Palem, Barbara B. Simons
September 1993 **ACM Transactions on Programming Languages and Systems (TOPLAS)**, Volume 15 Issue 4

Publisher: ACM Press

Full text available:  [pdf\(1.89 MB\)](#)

Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

We present a polynomial time algorithm for constructing a minimum completion time schedule of instructions from a basic block on RISC machines such as the Sun SPARC, the IBM 801, the Berkeley RISC machine, and the HP Precision Architecture. Our algorithm can be used as a heuristic for RISC processors with longer pipelines, for which there is no known optimal algorithm. Our algorithm can also handle time-critical instructions, which are instructions that have to be completed by a specific ti ...

Keywords: NP-complete, RISC machine scheduling, compiler optimization, deadline, greedy algorithm, instruction scheduling, latency, pipeline processor, register allocation

45 Scheduling real-time traffic with deadlines over a wireless channel

Sanjay Shakkottai, R. Srikant
January 2002 **Wireless Networks**, Volume 8 Issue 1

Publisher: Kluwer Academic Publishers

Full text available:  [pdf\(244.76 KB\)](#)

Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

Recently, there has been widespread interest in the extension of data networks to the wireless domain. However, scheduling results from the wireline domain do not carry over to wireless systems because wireless channels have unique characteristics not found in wireline channels, namely, limited bandwidth, bursty channel errors and location-dependent channel errors. In this paper, we study the problem of scheduling multiple real-time streams with deadlines, over a shared channel. We show that, in ...

Keywords: Quality-of-Service, bursty channels, real-time traffic, scheduling

46 Object-oriented real-time language design: constructs for timing constraints

Yutaka Ishikawa, Hideyuki Tokuda
September 1990 **ACM SIGPLAN Notices , Proceedings of the European conference on object-oriented programming on Object-oriented programming systems, languages, and applications OOPSLA/ECOOP '90**, Volume 25 Issue 10

Publisher: ACM Press

Full text available:  [pdf\(1.10 MB\)](#)

Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

We propose a new object-oriented programming language called RTC++ for programming real-time applications. RTC++ is an extension of C++ and its features are to specify i) a real-time object which is an active entity, ii) timing constraints in an operation as well as in statements, and iii) a periodic task with rigid timing constraints. In this paper, we first discuss real-time programming issues and what language support should be provided for building real-time applications. The ...

47 Static and Dynamic Variable Voltage Scheduling Algorithms for Real-Time Heterogeneous Distributed Embedded Systems

Jiong Luo, Niraj K. Jha
January 2002 **Proceedings of the 2002 conference on Asia South Pacific design automation/VLSI Design**

Publisher: IEEE Computer Society

Full text available: [pdf\(209.34 KB\)](#)

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This paper addresses the problem of static and dynamic variable voltage scheduling of multi-rate periodic task graphs (i.e., tasks with precedence relationships) and aperiodic tasks in heterogeneous distributed real-time embedded systems. Such an embedded system may contain general-purpose processors, field-programmable gate arrays (FPGAs) and application-specific integrated circuits (ASICs). Variable voltage scheduling is performed only on general-purpose processors. The static scheduling algor ...

Keywords: low-power, scheduling, real-time systems, embedded systems

48 [Test: A constraint-based solution for on-line testing of processors embedded in real-time applications](#)



Author: Marcelo Moraes, Érika Cota, Luigi Carro, Flávio Wagner, Marcelo Lubaszewski

September 2005 **Proceedings of the 18th annual symposium on Integrated circuits and system design SBCCI '05**

Publisher: ACM Press

Full text available: [pdf\(133.86 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Software-based self-test has been proposed as a low-cost strategy for on-line periodic testing of embedded processors. In this paper, we show that structural test programs composed only by regular deterministic self-test routines may be unfeasible in a real-time embedded platform. Hence, we propose a method to consciously select a set of test routines from different test approaches to compose a test program for an embedded processor. The proposed method not only ensures the periodical execution ...

Keywords: embedded processors, on-line testing, real-time systems, software-based self-test, test space exploration

49 [CRUSADE: hardware/software co-synthesis of dynamically reconfigurable heterogeneous real-time distributed embedded systems](#)



Author: Bharat P. Dave

January 1999 **Proceedings of the conference on Design, automation and test in Europe**

Publisher: ACM Press

Full text available: [pdf\(59.35 KB\)](#) Additional Information: [full citation](#), [citations](#), [index terms](#)

50 [On real-time transactions](#)



Author: John A. Stankovic, Wei Zhao

March 1988 **ACM SIGMOD Record**, Volume 17 Issue 1

Publisher: ACM Press

Full text available: [pdf\(858.69 KB\)](#) Additional Information: [full citation](#), [abstract](#), [citations](#), [index terms](#)

Next generation real-time systems will require greater flexibility and predictability than is commonly found in today's systems. These future systems include the space station, integrated vision/robotics/AI systems, collections of humans/robots coordinating to achieve common objectives (usually in hazardous environments such as undersea exploration or chemical plants), and various command and control applications. The complexity of such systems due to timin ...

51 [Implementing soft real-time agent control](#)



Author: Régis Vincent, Bryan Horling, Victor Lesser, Thomas Wagner

May 2001 **Proceedings of the fifth international conference on Autonomous agents**

Publisher: ACM Press

Full text available: [pdf\(124.50 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

Real-time control has become increasingly important as technologies are moved from the lab into real world situations. The complexity associated with these systems increases as control and autonomy are distributed, due to such issues as precedence constraints, shared resources, and the lack of a complete and consistent world view. In this paper we describe a real-time environment requiring distributed control, and how we modified our existing multi-agent technologies to meet this need. T ...

52 Papers: Markov decision processes: A polynomial algorithm for decentralized Markov decision processes with temporal constraints

 Aurélie Beynier, Abdel-Illah Mouaddib

July 2005 **Proceedings of the fourth international joint conference on Autonomous agents and multiagent systems AAMAS '05**

Publisher: ACM Press

Full text available: [pdf\(384.69 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

One of the difficulties to adapt MDPs for the control of cooperative multi-agent systems, is the complexity issued from Decentralized MDPs. Moreover, existing approaches can not be used for real applications because they do not take into account complex constraints about the execution. In this paper, we present a class of DEC-MDPs, OC-DEC-MDP, that can handle temporal and precedence constraints. This model allows several autonomous agents to cooperate so as to complete a set of tasks without com ...

Keywords: Markov decision processes, multi-agent systems, planning, uncertainty

53 A model of real time control system production

 M. N. Matelan

June 1976 **ACM SIGDA Newsletter**, Volume 6 Issue 2

Publisher: ACM Press

Full text available: [pdf\(1.75 MB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#)

Many facets of Computer Science and associated technologies may be profitably viewed as dedicated real time control activities. Production of systems to exercise such control has been difficult and costly. An abstract model of the process of producing these systems is presented. The model indicates three areas of the design problem amenable to automation: 1) the selection and configuration of hardware; 2) the production of software; and 3) the selection of a monitor to maintain real time integri ...

54 Scheduling time-critical instructions on RISC machines

 Krishna Palem, Barbara Simons

December 1989 **Proceedings of the 17th ACM SIGPLAN-SIGACT symposium on Principles of programming languages**

Publisher: ACM Press

Full text available: [pdf\(1.17 MB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

An instruction or a set of instructions can be considered time critical if their execution is required to free up a resource. Time critical instructions might be used to make shared resources such as registers more quickly available for reuse; or they might be used for real time computations, portions of which are critical for the operation of some piece of equipment. In this paper we present a polynomial time algorithm for optimally scheduling instructions with or without time critical con ...

55 Scheduling real-time traffic with deadlines over a wireless channel

 Sanjay Shakkottai, R. Srikant

August 1999 **Proceedings of the 2nd ACM international workshop on Wireless mobile multimedia**

Publisher: ACM Press

Full text available: [pdf\(946.87 KB\)](#) Additional Information: [full citation](#), [references](#), [citations](#), [index terms](#)

56 OOPM/RT: a multimodeling methodology for real-time simulation

 Kangsun Lee, Paul A. Fishwick
April 1999 **ACM Transactions on Modeling and Computer Simulation (TOMACS)**, Volume 9 Issue 2

Publisher: ACM Press

Full text available: [pdf\(317.58 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#), [review](#)

When we build a model of real-time systems, we need ways of representing the knowledge about the system and also time requirements for simulating the model. Considering these different needs, our question is "How can we determine the optimal model that simulates the system by a given deadline while still producing valid outputs at an acceptable level of detail?" We have designed OOPM/RT (Object-Oriented Physical Modeler for Real-Time Simulation) methodology. The OOPM/RT framework ...

Keywords: model abstraction, model selection, modeling methodology, real-time simulation, real-time systems

57 Dynamic voltage scaling for the schedulability of jitter-constrained real-time embedded systems

B. Mochocki, R. Racu, R. Ernst
May 2005 **Proceedings of the 2005 IEEE/ACM International conference on Computer-aided design ICCAD '05**

Publisher: IEEE Computer Society

Full text available: [pdf\(256.63 KB\)](#) Additional Information: [full citation](#), [abstract](#)

Jitter is a critical problem for the design of both distributed embedded systems and real-time control systems. This work considers meeting the completion jitter constraints of a set of independent, periodic, hard real-time tasks scheduled according to a preemptive fixed-priority scheme. Control over completion jitter is achieved by judiciously applying dynamic voltage scaling (DVS). Through simulation, the proposed method is shown to be an effective tool to meet jitter constraints on a variety ...

58 An approximate analysis of waiting time in multi-class M/G/1/./EDF queues

 Ken Chen, Laurent Decreusefond
May 1996 **ACM SIGMETRICS Performance Evaluation Review , Proceedings of the 1996 ACM SIGMETRICS international conference on Measurement and modeling of computer systems SIGMETRICS '96**, Volume 24 Issue 1

Publisher: ACM Press

Full text available: [pdf\(876.35 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

The Earliest-Deadline-First (EDF) queueing discipline is being more and more widely used for handling time-sensitive applications in computer systems and networks. In this paper, we consider an arbitrary number of traffic classes with class-specific soft-deadline. A soft-deadline is a target waiting-time limit that can be missed. EDF queueing has been proved to minimize the maximum delay overflow related to this limit. We propose a quantitative analysis, through the metric of mean waiting time, ...

Keywords: communication networks, computer architecture, multimedia systems, real-time systems, stochastic modeling

59 Overhead-Conscious Voltage Selection for Dynamic and Leakage Energy Reduction of Time-Constrained Systems

Alexandru Andrei, Marcus Schmitz, Petru Eles, Zebo Peng, Bashir M. Al-Hashimi
February 2004 **Proceedings of the conference on Design, automation and test in**

Europe - Volume 1**Publisher:** IEEE Computer SocietyFull text available:  [pdf\(211.20 KB\)](#) Additional Information: [full citation](#), [abstract](#), [index terms](#)

Dynamic voltage scaling and adaptive body biasing have been shown to reduce dynamic and leakage power consumption effectively. In this paper, we optimally solve the combined supply voltage and body bias selection problem for multi-processor systems with imposed time constraints, explicitly taking into account the transition overheads implied by changing voltage levels. Both energy and time overheads are considered. We investigate the continuous voltage scaling as well as its discrete counterpart ...

60 [Dynamic adaptation for fault tolerance and power management in embedded real-time systems](#)  Ying Zhang, Krishnendu ChakrabartyMay 2004 **ACM Transactions on Embedded Computing Systems (TECS)**, Volume 3 Issue 2**Publisher:** ACM PressFull text available:  [pdf\(340.82 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Safety-critical embedded systems often operate in harsh environmental conditions that necessitate fault-tolerant computing techniques. In addition, many safety-critical systems execute real-time applications that require strict adherence to task deadlines. These embedded systems are also energy-constrained, since system lifetime is determined largely by the battery lifetime. In this paper, we investigate dynamic adaptation techniques based on checkpointing and dynamic voltage scaling (DVS) for f ...

Keywords: Checkpointing, dynamic voltage scaling

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